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# Maladies Vectorisées par les Tiques chez les Ongulés Sauvages de Montagne : Revue Systématique

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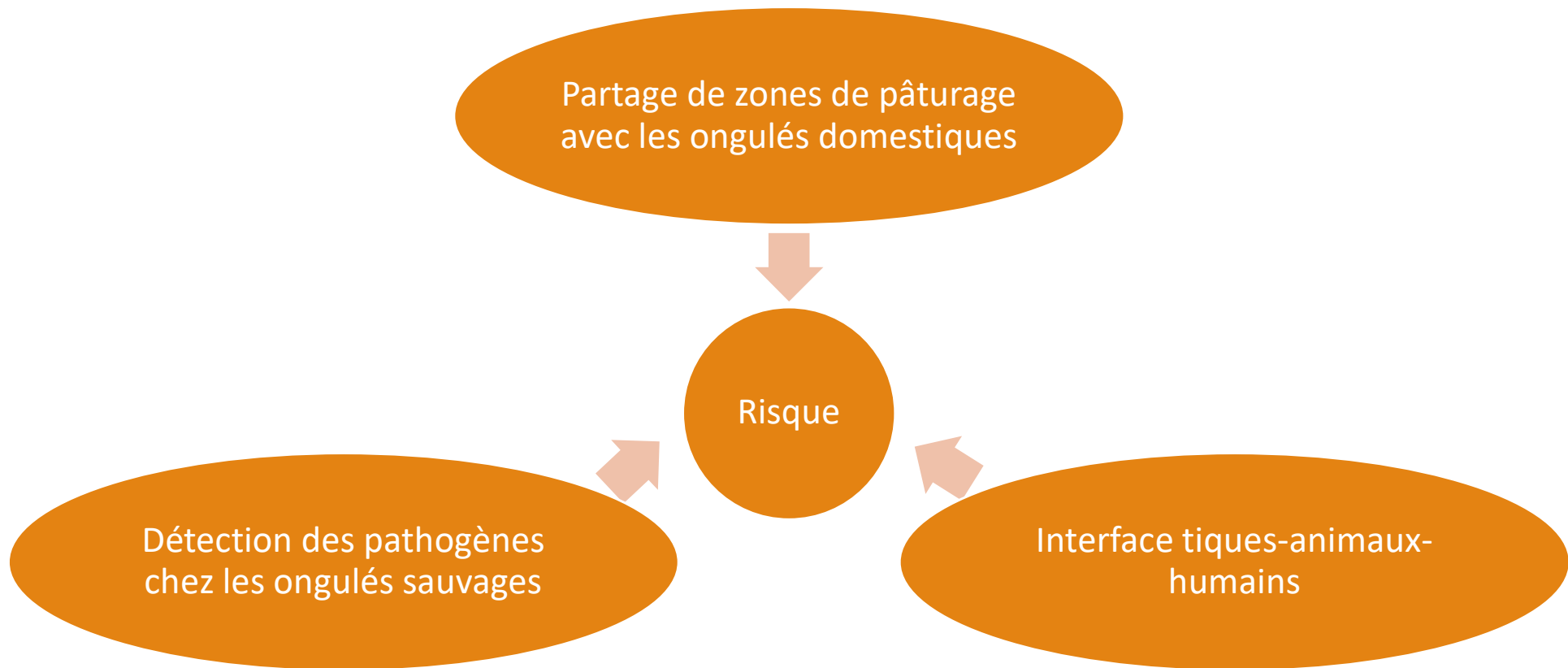
# I. Introduction

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- Les tiques sont les 2<sup>nd</sup> plus importants transmetteurs de maladies vectorielles, suite aux moustiques et les 1<sup>er</sup> dans les zones tempérés
- Les ongulés sauvages de montagne sont fréquemment parasités par les tiques → effet du changement climatique sur la dynamique des tiques a augmenté l'interaction tiques-hôte.
- Quelques pathogènes vectorisés par les tiques:
  - ✓ ➤ *Anaplasma* spp.
  - ✓ ➤ *Babesia* spp.
  - *Theileria* spp.
  - ✓ ➤ *Borrelia burgdorferi* s.l. → **maladie vectorisée par les tiques la plus commune en Europe**
  - ✓ ➤ *Rickettsia* spp.
  - ✓ ➤ *Coxiella burnetii* (Fièvre Q)

# I. Introduction

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# I. Introduction

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- Revue systématique portant sur l'anaplasmose, babesiose, theileriose, rickettsiose, borreliose de Lyme et la fièvre Q chez le mouflon, chamois et bouquetin en Europe.
- **Objectifs** → faire un bilan sur:
  - La distribution de ces pathogènes chez les ongulés sauvages;
  - Le statut hôte/réservoir des ongulés sauvages vis-à-vis certains pathogènes;
  - Impact clinique.

## II. Matériel et Méthode

# 1. Recherche de base de données

➤ Recherche dans la base de données Web of Science le 14 Décembre 2018 s'étendant de 1960 à 2018

Web of Science

➤ Mots clefs utilisés:

Ongulés sauvages de montages

mouflon OR chamois OR isard OR steinbock OR bouquetin OR ibex

Maladies/pathogènes vectorisées par les tiques

AND

anaplasma OR anaplasmosis OR rickettsia OR rickettsiosis OR ehrlichia OR ehrlichiosis OR babesia OR babesiosis OR piroplasma OR piroplasmosis OR theileria OR theileriosis OR borrelia OR borreliosis OR coxiella OR coxiellosis OR tick

## 2. Tri de la littérature

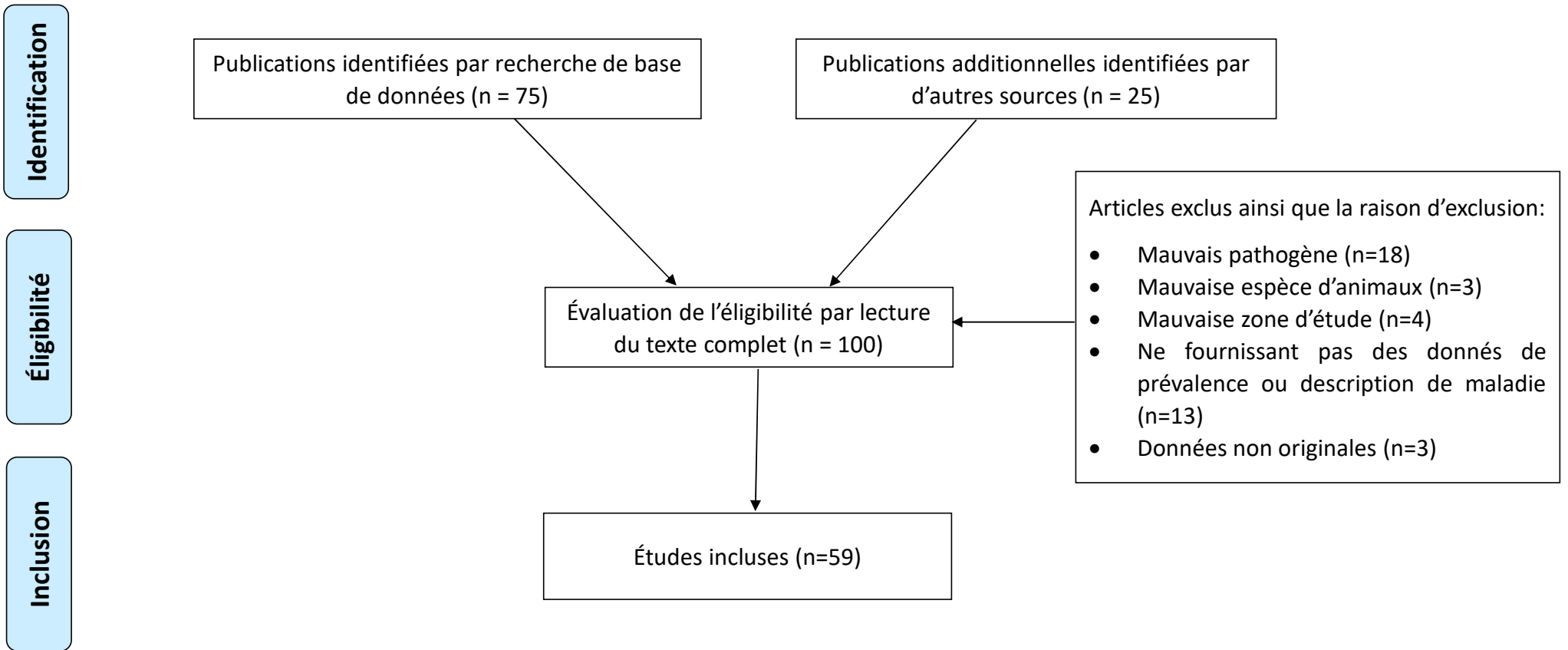
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Critères d'exclusion:

- Pathogène ≠ *Anaplasma* spp., *Babesia* spp., *Theileria* spp., *Borrelia burgdorferi* s.l., *Rickettsia* spp. et *Coxiella burnetii*
- Hôte ≠ Mouflon, chamois ou bouquetin
- Zone d'étude ≠ Europe
- Articles fournissant des résultats ≠ prévalence, détection de pathogène, description de maladie clinique
- Revues bibliographiques, livres et toute publication ne fournissant pas des données originales.



# Diagramme PRISMA



# 3. Analyse de qualité

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➤ Deux types d'échantillons collectés dans les études incluses:

➤ Tissus d'animaux (sang, sérum, rate, nœud lymphatiques, etc.)

➤ Tiques collectés sur des ongulés sauvages



➤ Analyse de qualité des articles inclus suivant les recommandations de Public Health Ontario Meta-tool for Quality Appraisal (PHO MetaQAT 1.0) ➔ pas de calcul de score pour la qualité

➤ Deux reviewers indépendants ont complétés l'analyse de qualité ➔ résultats mis en commun et les différences ont été résolues par consensus et approuvées par un 3<sup>ème</sup> reviewer.

Study identification		Assessment of relevancy	Assessment of reliability	Assessment of validity				Assessment of applicability	
Year	Reference	Does the study address a topic(s) relevant to the issue under investigation?	a) Is the study presented clearly?	b) Are the research methodology and results clearly described?	a) Is the study methodology appropriate for the scope of research	b) Is the research methodology free from bias?	c) Are the authors' conclusions explicit and transparent?	d) Can I be confident about the findings?	Can the results be applied with the scope of public health?
		[1] Was the justification for the study clearly stated? [2] Do the results apply to the issue under consideration? [3] How similar or different is the study population or setting to yours? Is a difference likely to matter for the issue at hand? [4] Is the research design appropriate for the methodology you are considering? (For example if you are considering a systematic review, you will only be reviewing certain types of publications).	[1] Is the rationale for the study clearly stated, and does the study focus on a clearly defined issue? [2] Can the study be reproduced with the information provided?	[1] Are tick collection methods defined? [2] Are host species reported? [3] Are positive and negative controls explicitly and clearly described? [4] Is the tick stage identified? [5] Are collection locales clearly identified? [6] Is GenBank submission included where applicable?	[1] Is the research question congruent with the study design? [2] Are statistical-analytic methods appropriate for the design and/or the question?	[1] Were there major sources of bias with respect to study design? [2] Are all comprehensive factors included in the research? i.e. were important factors not measured that are critical to interpretation [3] Are the results consistent within the study? [4] Can chance findings be ruled out?	[1] Are the results conclusive? [2] Are the authors conclusions clearly derived from the results? [3] Are the potential discrepancies discussed? [4] Are limitations of work described?	[1] Are there any major methodological flaws that limit the validity of the findings? [2] Are the study's results similar to those of the existing body of literature? If not are the reasons for the difference clearly explained?	[1] Can the study results be interpreted and analyzed within the context of public health?

**Échantillons de tiques**

Study identification		Assessment of relevancy	Assessment of reliability	Assessment of validity			Assessment of applicability		
Year	Reference	Does the study address a topic(s) relevant to the issue under investigation?	a) Is the study presented clearly?	b) Are the research methodology and results clearly described?	a) Is the study methodology appropriate for the scope of research	b) Is the research methodology free from bias?	c) Are the authors' conclusions explicit and transparent?	d) Can I be confident about the findings?	Can the results be applied with the scope of public health?
		<p>[1] Was the justification for the study clearly stated?</p> <p>[2] Do the results apply to the issue under consideration?</p> <p>[3] How similar or different is the study population or setting to yours? Is a difference likely to matter for the issue at hand?</p> <p>[4] Is the research design appropriate for the methodology you are considering? (For example if you are considering a systematic review, you will be reviewing only certain types of publications).</p>	<p>[1] Is the rationale for the study clearly stated, and does the study focus on a clearly defined issue?</p> <p>[2] Is the conduct of the study clearly described and easy to follow?</p> <p>[3] Can you identify the research design?</p> <p>[4] Are all relevant results included?</p> <p>[5] Are the findings presented and discussed with the appropriate context?</p> <p>[6] Is there a conflict of interest statement?</p> <p>[7] Can the study be reproduced with the information provided?</p>	<p>[1] Does the methodology describe the population studied, the intervention given, and the outcomes?</p> <p>[2] Are all sources of information clearly identified?</p> <p>[3] Are inclusion and exclusion criteria defined?</p> <p>[4] Are the statistical and/or analytical methods described?</p> <p>[5] If applicable, are the results reported in data tables consistent with those described in the results section?</p> <p>[6] Could the methods be reproduced based on the information provided?</p>	<p>[1] Is the research question congruent with the study design?</p> <p>[2] Does the methodology match the theory or the conceptual model?</p> <p>[3] Are the statistical/analytic methods appropriate for the design and/or the question?</p>	<p>[1] Were there major sources of bias with respect to: study design? Study participants' inclusion/exclusion? Measurement of exposure/outcome or important confounder/predictor?</p> <p>[2] Are all comprehensive factors included in the research? I.e. were important factors not measured that are critical to interpretation?</p> <p>[3] Are the results consistent within the study?</p> <p>[4] Can chance findings be ruled out?</p> <p>[5] Were the analyses carried out appropriately (according the previously stated method)</p>	<p>[1] Are the results conclusive?</p> <p>[2] Are the authors conclusions clearly derived from the results?</p> <p>[3] Are the potential discrepancies discussed?</p> <p>[4] Are limitations of work described?</p>	<p>[1] Are there any major methodological flaws that limit the validity of the findings (these may have been identified in points a or b)?</p> <p>[2] Are the study's results similar to those of the existing body of literature? If not, are the reasons for the difference clearly explained?</p>	<p>[1] Can the study results be interpreted and analyzed within the context of public health?</p>

**Échantillons de tissus  
d'animaux**

# 4. Extraction des données

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- La collecte des données a été faite de façon individuelle pour chaque article.
- Les données collectées:

Études sur échantillons de tiques
Protocole de l'étude
Zone d'étude
Période d'échantillonnage
Espèce/genre + stage/sexe des tiques
Nombre d'animaux inclus dans l'étude
Test diagnostique utilisé
Prévalence et séquençage lorsque possible

Études sur échantillons de tissus d'animaux
Protocole de l'étude
Zone d'étude
Période d'échantillonnage
Type d'échantillon (sang, rate, autres tissus)
Nombre d'animaux inclus dans l'étude
Test diagnostique utilisé
Prévalence et séquençage lorsque possible
Description de maladie symptomatique

# 5. Synthèse des résultats

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- Deux tableaux de synthèse indépendants suivant le type d'échantillons (Tissus d'animaux Vs. Tiques) contenant toutes les données collectées + 2 tableaux de synthèse résumés.
- Cartes: pour chaque espèce d'ongulés sauvages, une carte de distribution de la population ainsi que la détection des pathogènes a été dressée.
- Description clinique des maladies

### III. Résultats et Discussion

## Échantillons de tiques

Reference	Animal species (N° of animals)	Amplified gene (size)	Pathogen	Tick species collected (N° and sex)	N° of pools	Positive/tested (%)	Sequence analysis	Study area	Study period
(Varela-Castro, et al., 2018)	<i>Capra pyrenaica</i> (52)	IS1111a (687 bp)	<i>C. burnetii</i>	<i>Rh. sanguineus</i> (5)	-	3/5 (60%)	<i>C. burnetii</i>	Spain (Catalonia)	2011-2015
				<i>Rh. bursa</i> (601)	103	52/103 (50.5%)			
				<i>H. sulcata</i> (28)	19	6/19 (31.6%)			
				<i>H. punctata</i> (23)	20	5/20 (25%)			
				<i>D. marginatus</i> (11)	9	1/9 (11.1%)			
				<i>Hy. marginatum</i> (1)	-	0/1 (0%)			

## Échantillons de tissus d'animaux

Reference	Animal species (N° of animals)	Sample collected	Diagnostic test	Details on the assay	Pathogen	Positive/tested (%)	Sequence analysis	N° associated on the map	Study area	Study period
(Varela-Castro, et al., 2018)	<i>Capra pyrenaica</i> (134)	Blood (130)	ELISA	<i>C. burnetii</i> antibodies	<i>C. burnetii</i>	38/130 (30%)	-	7*	Spain (Catalonia)	2011-2015
		Spleen (72)	PCR	IS1111a (687 bp)	<i>C. burnetii</i>	7/72 (9.7%)	<i>C. burnetii</i>	8		
		Submandibular lymph node (89)				4/89 (4.5)				



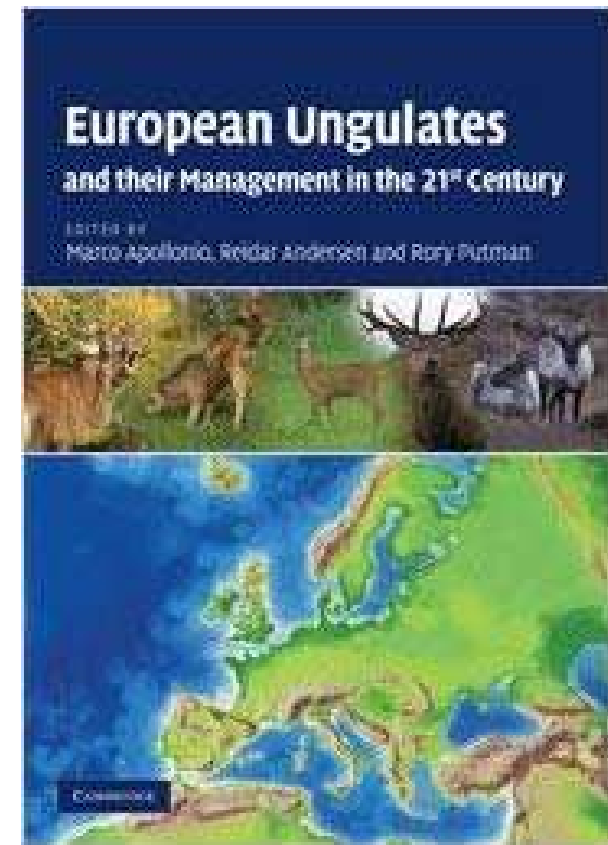
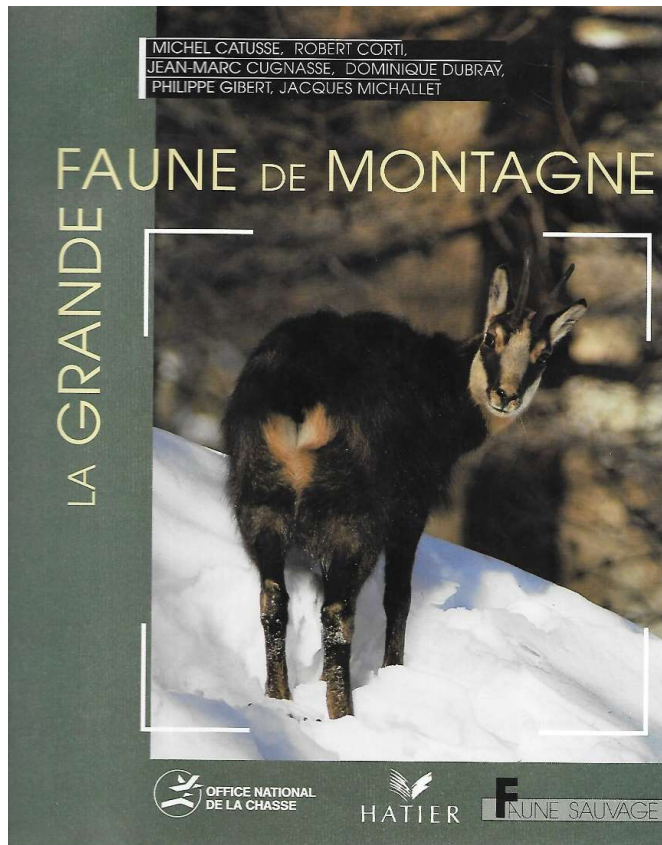
(<sup>a</sup>): marque des études menées sur un petit nombre de tiques (<10)

(<sup>b</sup>): marque des études menées sur des tiques en pools

(NA): aucune données existante

Animal species	Tick species	Anaplasma spp.	Babesia spp.	Theileria spp.	Borrelia burgdorferi s.l.	Rickettsia spp.	Coxiella burnetii
Mouflon (9)	<i>H. punctata</i>	✖	✖	NA	NA	✓ (0-30%)	✓ (100%) <sup>a,b</sup>
	<i>H. sulcata</i>	✓ (24%) <sup>b</sup>	NA	NA	NA	✓ (0-56%) <sup>b</sup>	✓ (12%)
	<i>Hy. m. marginatum</i>	✖	NA	NA	NA	✓ (<20%) <sup>a</sup>	✖
	<i>Hy. a. excavatum</i>	✖	NA	NA	NA	✖	✓ (13%) <sup>b</sup>
	<i>D. marginatus</i>	NA	NA	NA	NA	✖	NA
	<i>Rh. bursa</i>	✖	NA	NA	NA	✓ (0-23%) <sup>b</sup>	✓ (40%) <sup>b</sup>
	<i>Rh. turanicus</i>	✖	NA	NA	NA	✓ (~20%)	✓ (40%) <sup>b</sup>
	<i>Rh. sanguineus</i>	✖	✖	NA	NA	✓ (0-5%)	✓ (100%) <sup>a,b</sup>
	<i>I. ricinus</i>	✓ (0-52%)	✓ (0-1%)	NA	✓ (0-8%)	✓ (3-9%)	✓ (16%) <sup>a</sup>
	<i>I. gibosus</i>	✖	NA	NA	NA	✖	✖
Chamois (3)	<i>H. sulcata</i>	NA	NA	NA	NA	NA	NA
	<i>H. punctata</i>	NA	NA	NA	NA	NA	NA
	<i>I. ricinus</i>	NA	✓ (<1%)	NA	✖	✓ (6%)	NA
Ibex (1)	<i>Rh. bursa</i>	NA	NA	NA	NA	NA	✓ (50%)
	<i>Rh. sanguineus</i>	NA	NA	NA	NA	NA	✓ (60%) <sup>a</sup>
	<i>H. sulcata</i>	NA	NA	NA	NA	NA	✓ (31%)
	<i>H. punctata</i>	NA	NA	NA	NA	NA	✓ (25%)
	<i>D. marginatus</i>	NA	NA	NA	NA	NA	✓ (11%) <sup>b</sup>
	<i>Hy. m. marginatum</i>	NA	NA	NA	NA	NA	✖

Pathogen	Diagnostic test	Mouflon	Chamois	Ibex
<i>Anaplasma spp.</i>	Molecular	✓ (2.5-74.4%)	✓ (0-26.1%)	✓ (16.7%)
	Serology	✓ (22%)	✓ (28.2%)	✗
	Clinical signs	✗	✗	✗
	Positive ticks	✓	NA	NA
<i>Babesia spp.</i>	Molecular	✓ (0-6.5%)	✓ (0-22%)	✓ (1.5-5.5%)
	Serology	✓ (12%)	✗	✓ (32.6%)
	Clinical signs	✗	✓	✓
	Positive ticks	✓	✓	NA
<i>Theileria spp.</i>	Molecular	✓ (0-5%)	✓ (0-28.9%)	✗
	Serology	NA	✗	✗
	Clinical signs	✗	✗	✗
	Positive ticks	✗	NA	NA
<i>Rickettsia spp.</i>	Molecular	✓ (5-30%)	✗	✗
	Serology	NA	✗	✗
	Clinical signs	✗	✗	✗
	Positive ticks	✓	✓	NA
<i>Borrelia burgdorferi s.l.</i>	Molecular	✗	✗	✗
	Serology	✓ (16.6-76.5%)	✓ (40.4%)	✓ (28.5-30.8%)
	Clinical signs	✗	✗	✗
	Positive ticks	✓	✗	NA
<i>Coxiella burnetii</i>	Molecular	✓ (30%)	NA	✓ (0-9.8%)
	Serology	✓ (1.4-6.8%)	✗	✓ (1.8-30%)
	Clinical signs	✗	✗	✗
	Positive ticks	✓	NA	✓



**MOL**  
MAP OF LIFE

<https://mol.org/>

Carte 1: Mouflon (partie 1)

*Anaplasma* spp.  
125/168 (74.4%)

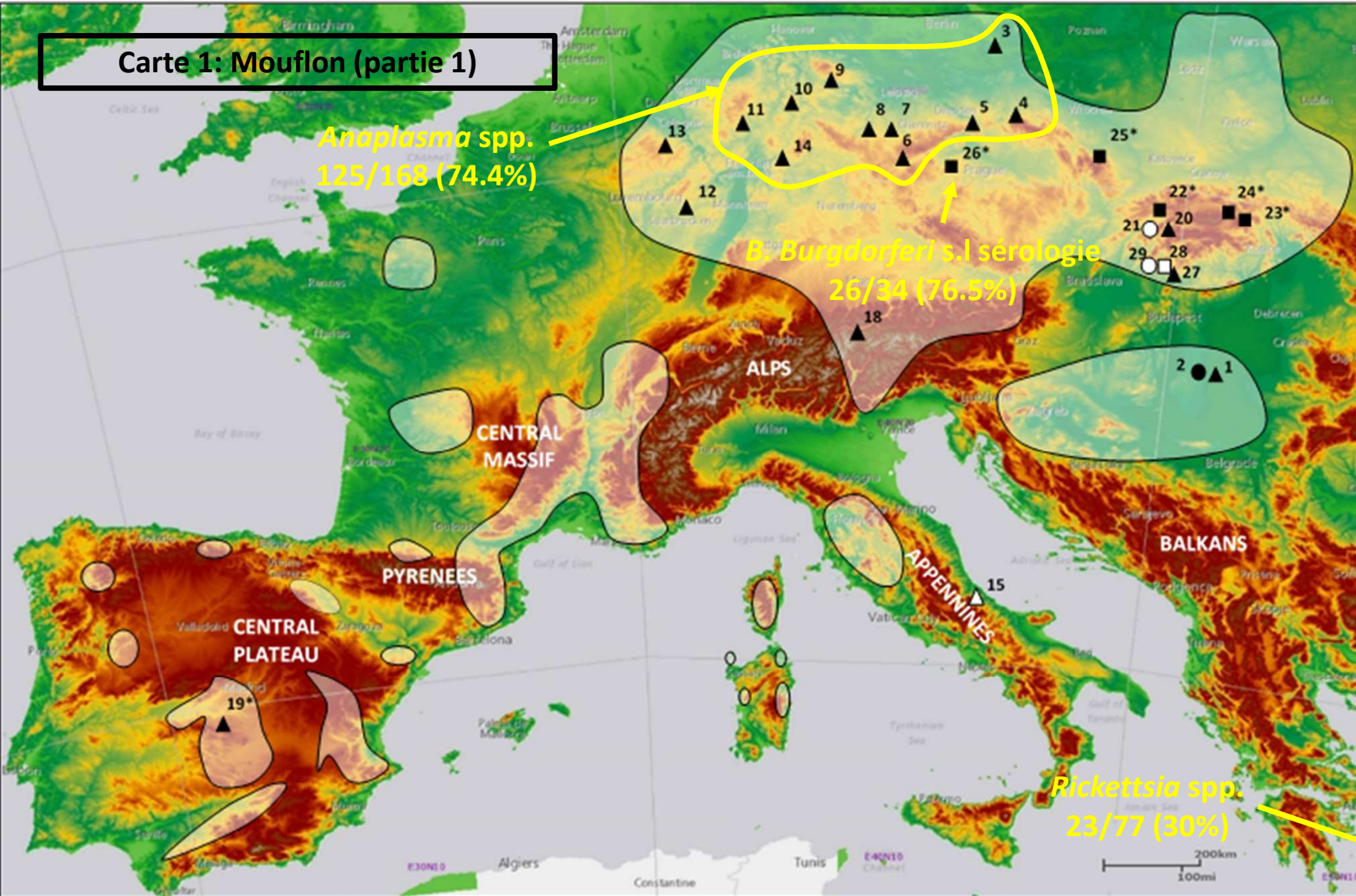
*B. burgdorferi* s.l. sérologie  
26/34 (76.5%)

*Rickettsia* spp.  
23/77 (30%)

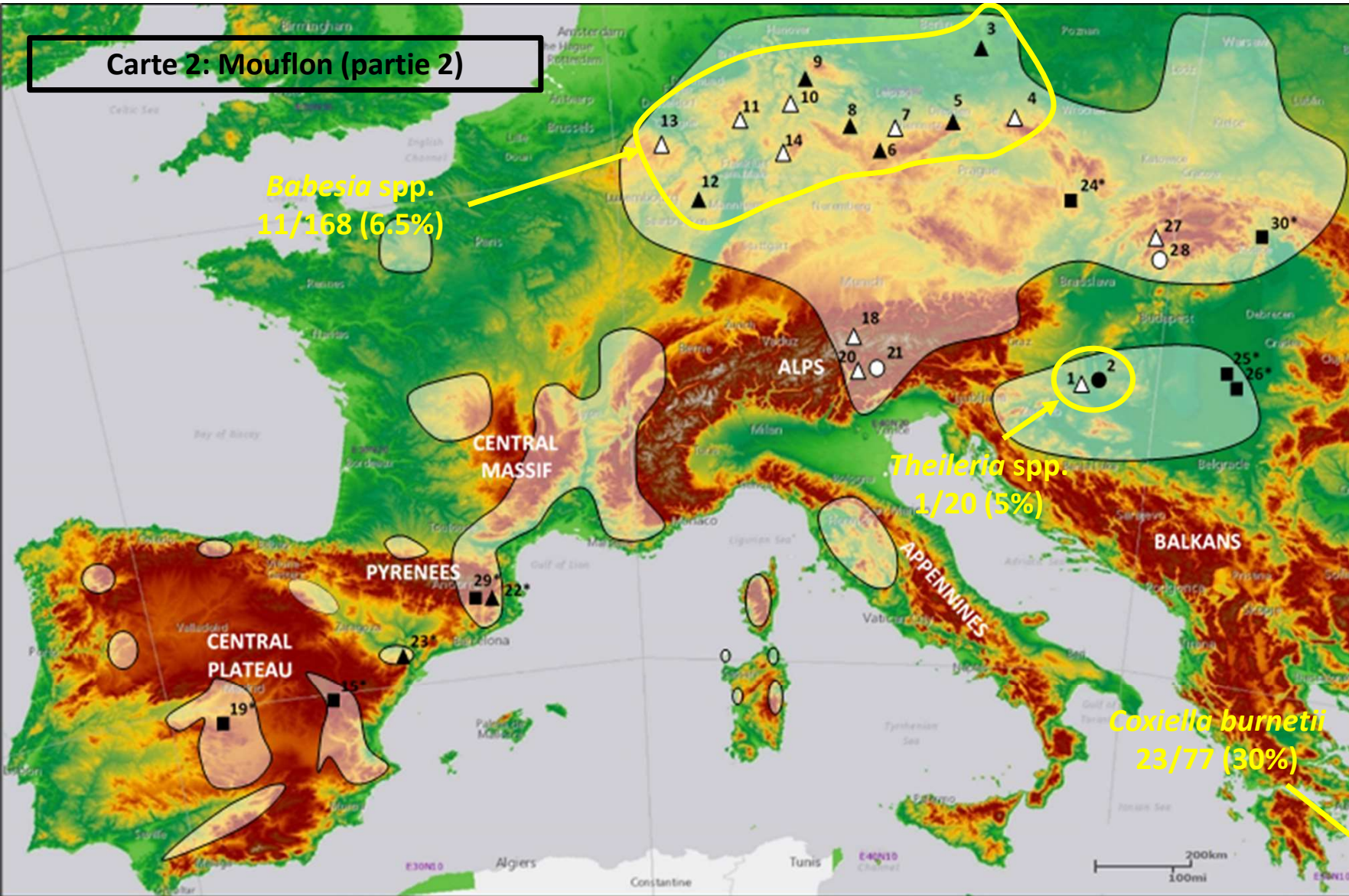
- ▲ : *Anaplasma* spp.
- : *Rickettsia* spp.
- : *Borrelia burgdorferi* s.l.
- 🐐 : Mouflon distribution

Shapes with white fill indicate molecular or serological analysis that revealed the absence of the pathogens.

\* indicates studies using serology (ELISA, complement fixation, IFA, IHA or other) to detect the seroprevalence of pathogens.



Carte 2: Mouflon (partie 2)



*Babesia* spp.  
11/168 (6.5%)

*Theileria* spp.  
1/20 (5%)

*Coxiella burnetii*  
23/77 (30%)

▲ : *Babesia* spp.

● : *Theileria* spp.

■ : *Coxiella burnetii*

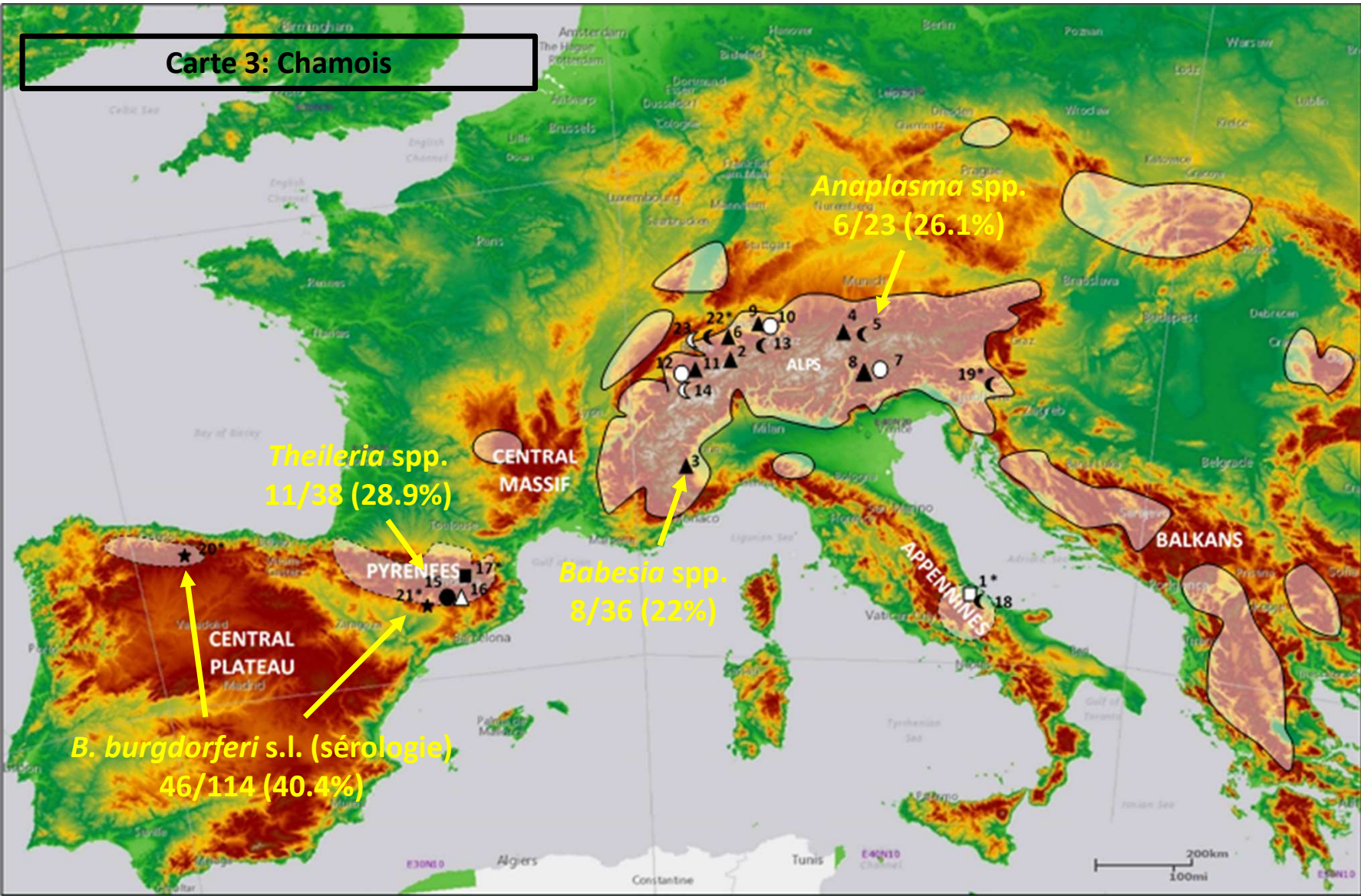
🐐 : Mouflon distribution

Shapes with white fill indicate molecular or serological analysis that revealed the absence of the pathogens.

\* indicates studies using serology (ELISA, complement fixation, IFA, IHA or other) to detect the seroprevalence of pathogens.

17\*  
16

Carte 3: Chamois

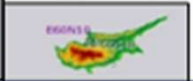


- ▲ : *Babesia* spp.
- : *Theileria* spp.
- : *Coxiella burnetii*
- ☾ : *Anaplasma* spp.
- ★ : *Borrelia burgdorferi* s.l.

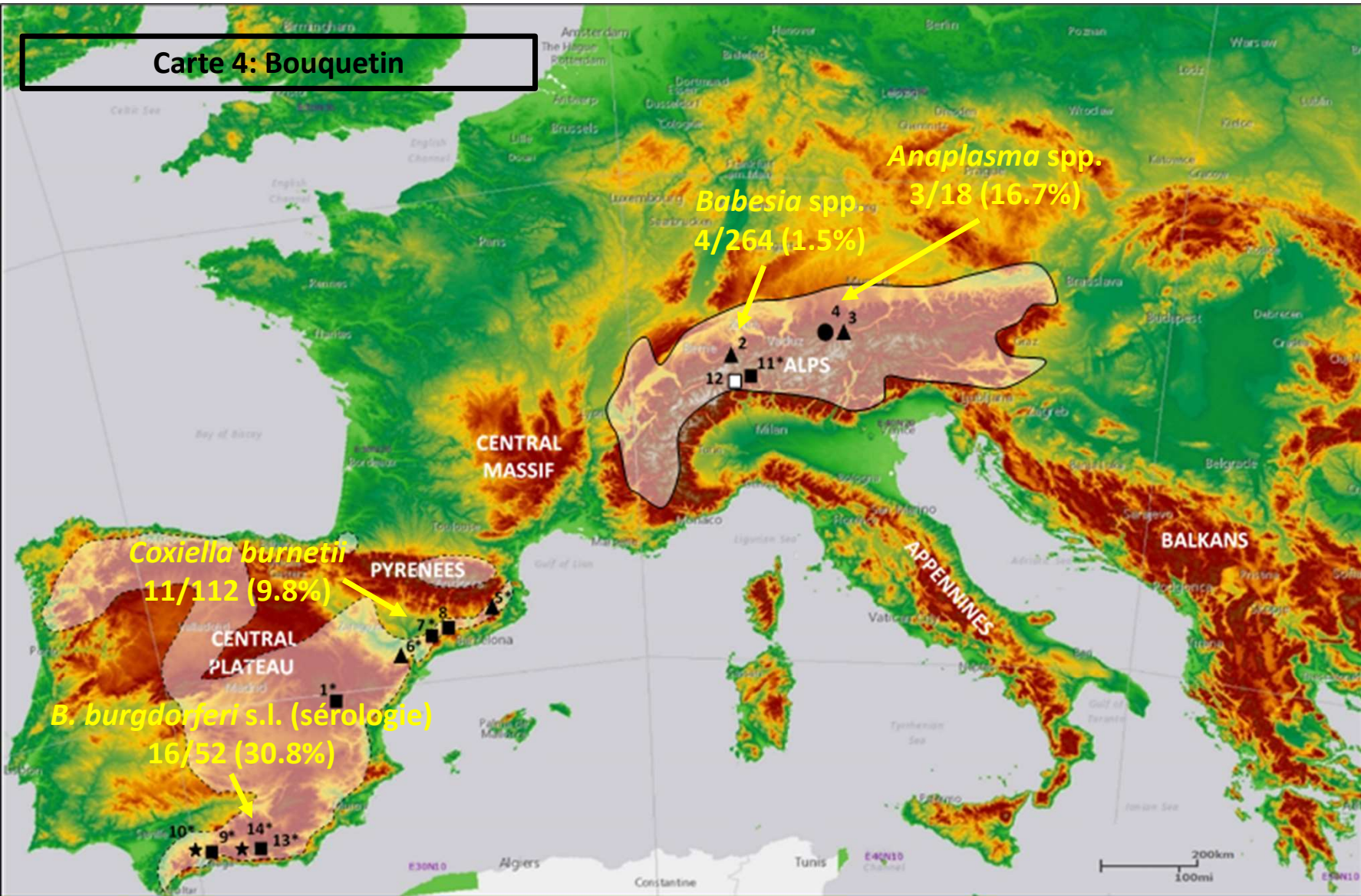
- : *Rupicapra rupicapra* distribution
- : *Rupicapra pyrenaica* distribution

Shapes with white fill indicate molecular or serological analysis that revealed the absence of the pathogens.

\* indicates studies using serology (ELISA, complement fixation, IFA, IHA or other) to detect the seroprevalence of pathogens.



Carte 4: Bouquetin

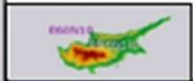


- ▲ : *Babesia* spp.
- : *Anaplasma* spp.
- : *Coxiella burnetii*
- ★ : *Borrelia burgdorferi* s.l.

- : Alpine ibex distribution
- : Spanish ibex distribution

Shapes with white fill indicate molecular or serological analysis that revealed the absence of the pathogens.

\* indicates studies using serology (ELISA, complement fixation, IFA, IHA or other) to detect the seroprevalence of pathogens.



# Maladies symptomatiques

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La babesiose est la seule maladie à avoir montré des signes cliniques chez les ongulés sauvages

- Bouvier, 1965: première publication décrivant la babesiose chez un chamois: anémie, ictère, hypertrophie du foie et de la rate.
- Hoby *et al.*, 2007: première publication détectant *Babesia* spp. par méthode PCR + signes cliniques et piroplasmés visualisés au frottis sanguin dans les érythrocytes.
- Aujourd'hui: 3 publications décrivant la babesiose symptomatique chez le chamois (Maioli *et al.*, 2012; Hoby *et al.*, 2007; Bouvier, 1965) + cas suspect signalés au Pic du Bazès entre 2007 et 2011.
- Marco *et al.*, 2000; décrit un cas de babesiose chez un bouquetin séropositif présentant les signes typique + observation de piroplasmés dans les érythrocytes lors du frottis sanguin.



## IV. Conclusion

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- Manque de connaissances sur les maladies vectorisées par les tiques chez les ongulés sauvages de montagne
- Nécessité de mener des études sur les tiques avec un plus grand nombre d'échantillons et sur des zones géographiques différentes.
- Nombre d'article concernant le mouflon, chamois et bouquetin est faible comparé au chevreuil.
- La babesiose présente un risque potentiel.
- Quid des risques pour les animaux domestiques et l'homme ?

Merci pour votre attention

